California Energy Use and Savings Potential

Residential Low Power Modes

The survey of measurements revealed few studies of standby or sleep mode energy consumption in California (or even the United States). Furthermore, each study estimated the values differently so they are difficult to compare. We calculated a total California energy use for each survey. These calculations are summarized in Table 1. These estimates are extremely uncertain!

Table 1. Estimates of energy use by low power modes in California

					Annual Energy Use (GWh/year)	
Source	**Metric**	**Multiplier**	**Standby**	**MW**	**Standby**	**Low Power**
Residential Estimates						
Ross & Meier	Watts/home	1.24E+07	67	831	7278	
Meier	Watts/home	1.24E+07	115	1426	12492	
Rainer et al	Watts/home	1.24E+07	50	620	5431	
Rainer et al	Watts/home	1.24E+07	84	1042	9124	
Recommended value	Watts/home	1.24E+07	70	868	7604	
Commercial Estimates						
Kawamoto et al	Office equipment electricity use in low power modes	12% of USA				1056
Meier extrapolated from Webber audits of offices	W/ft2	7.68E+09	0.065	499	4373	

We think that the Ross and Meier (Ross and Meier 2000) estimate is the most accurate. The ten houses were measured consistently and verified by examining the outside meter. Furthermore, the average total electricity use of the ten homes closely matched the average for all California homes. The 50 W estimate from Rainer et al (Rainer, Meier and Greenberg 1996) is based on a bottom-up estimate for only the major appliances and is certainly low. The 84 W estimate from Rainer et al and the 115 W from a compilation by Meier are based on inconsistent measurement procedures, non-representative homes, and possibly includes some appliances in active mode or sleep mode. We recommend that 70 W (~600 kWh/year) be used as the average standby per California household until more field measurements are completed. This corresponds to about 9% of an average California home's electricity use. Statewide, residential standby amounts to 870 MW or 6700 GWh/year.

We have no information on energy use of residential products in sleep mode, that is, the increment above standby. Common residential appliances with at least one mode between standby and active include:

- Desktop computer
- Laser printer
- VCR
- Home copier
- Fax machine
- Scanner

Energy consumption will depend on both the configuration and consumer habits (such as use of power strips, enabling power management, and switching off equipment). Saturations of these appliances are still increasing, so their consumption will be significant (if they aren't already).

The energy use from low power modes is likely to grow in the next decade. The primary drivers are the rapidly increasing number of appliances that have standby power and sleep modes. The products most likely to significantly affect energy use are:

- Digital set-top boxes
- DSL and cable modems
- Home networks (including a server/router)
- White goods (possibly connected to a network)
- Hard wired standby (smoke alarms, HVAC controls, etc.)

Digital-top boxes typically draw 10 – 40 W, depending on features. The confusion over digital TV standards may create a situation where each TV will need some sort of converter box. Thus, homes with three TVs could easily experience a (3 x 15 W =) 45 W increase in standby as a result of digital TV standards alone. DSL and cable modems often draw over 10 W, again depending on features. Most new white goods–from washing machines to room air conditioners–will have features that create standby power. In new homes, hard-wired standby could add as much as 30 W (that is, an increase of about 50%).

Other trends are working to reduce standby (and other low power modes). The most important driver is ENERGY STAR whose new specifications for the major consumer electronics products have pulled down standby levels. (It's not yet certain that ENERGY STAR will be equally successful in the area of set-top boxes and modems.) The federal Executive Order on standby devices will also help drive down standby levels because manufacturers will make all of their products comply with federal specifications. Finally, competitive pressures to make products more efficient, lighter, or better with respect to some feature that coincidentally lowers energy use, will lower energy consumption. Heightened consumer awareness may also contribute to lower standby levels. It is impossible to estimate the combined effect of these trends.

Residential Energy Savings Potential

Ross and Meier (Ross and Meier 2000) estimated the energy savings if all of the products with standby were cut from their present levels to 1 W. If this 1-watt scenario occurred, then total standby power use would fall 68%. This corresponds to a 55 W reduction. For comparison, new refrigerators–which have been heavily regulated–draw about 70 W. Many products with standby near the 1 W level are already available, but not necessarily in this country or with the same features. No similar studies of energy savings potential have been undertaken for sleep energy use.

Commercial Buildings

Data for energy consumption by low power modes in commercial buildings is even more scarce than for the residential sector. We attempted extrapolations from two studies. The calculation is summarized in Table 1. Neither estimate is satisfactory but they show different aspects.

The calculation based on Kawamoto et al. (Kawamoto et al. 2001) is based on their conclusion that about 12% of the energy used by office equipment could be attributed to low power modes. We assumed that California has 12% of the nation's office equipment (that is, proportional to its population), so low power modes are responsible for 1056 GWh/year. This includes some energy from the residential sector.

We estimated standby power use from an audit of office buildings reported Webber et al. (Webber et al. 2001) and assumptions regarding typical standby power levels for that equipment. This calculation yielded an intensity of standby power, in watts per unit of floor area. We multiplied by a rough estimate of commercial floor area in California to obtain an estimate of 4373 GWh/year.

Both of these numbers are highly uncertain and further analysis is necessary, so we have not recommended a value.

References

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Webber, C. A., J. A. Roberson, et al. (2001). Field Surveys of Office Equipment Operating Patterns. Berkeley CA, Lawrence Berkeley National Laboratory.